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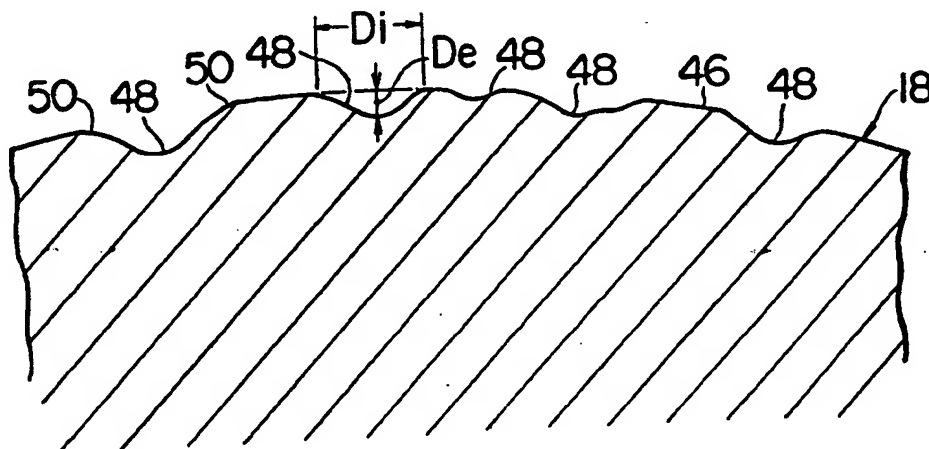
(58) Field of search

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(54) **Ball construction of a ball-and-socket joint and method of manufacture**

(57) The invention provides a ball-and-socket joint having a ball (18), in which, in order to effectively lubricate the mating surfaces of the ball and socket, a multiplicity of minute depressions (48) are formed on the ball surface for receiving a lubricant during use of the joint, and the boundary between the ball surface and each depression therein is rounded, instead of being sharp-edged, so that the lubricant readily flows into and out of the depressions with the relative angular displacement of the ball. The depression can be effectively formed by barreling or shot blasting. For barreling round or prismatic chips or a mixture may be used.



**FIG. 2**

**GB 2 229 765**

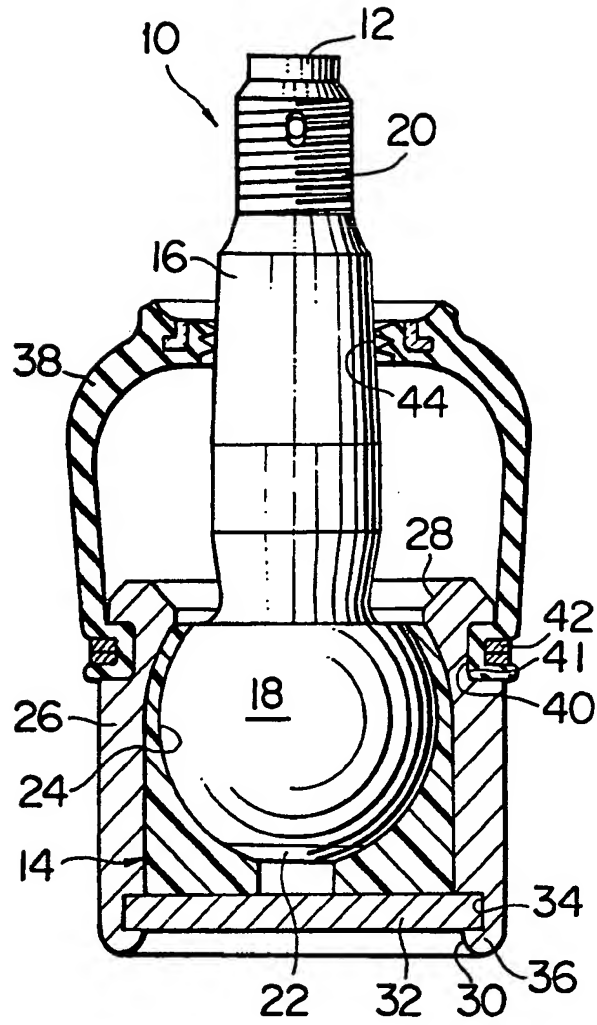


FIG. 1

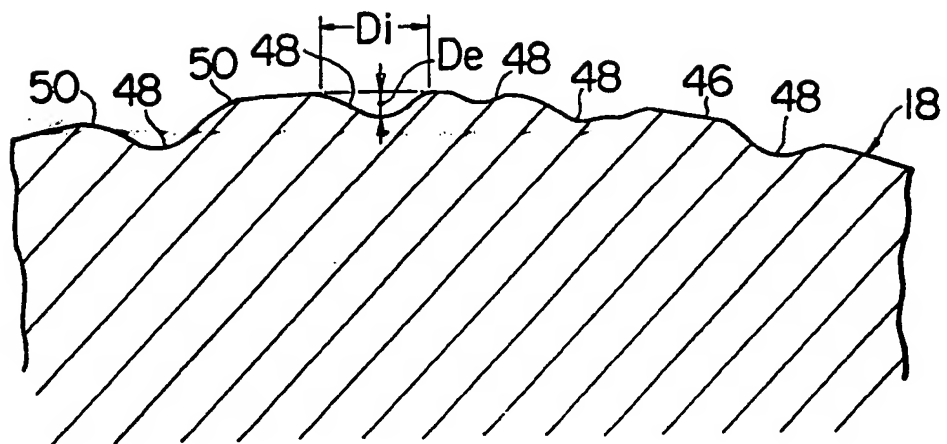


FIG. 2

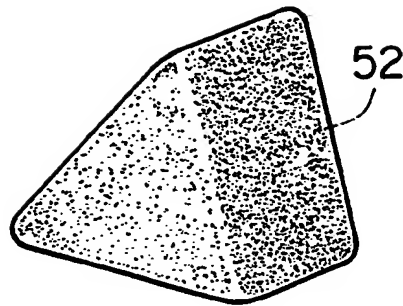


FIG. 3

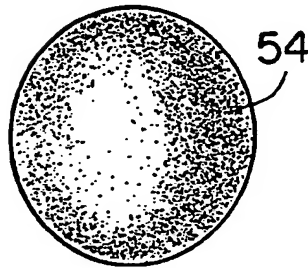


FIG. 4

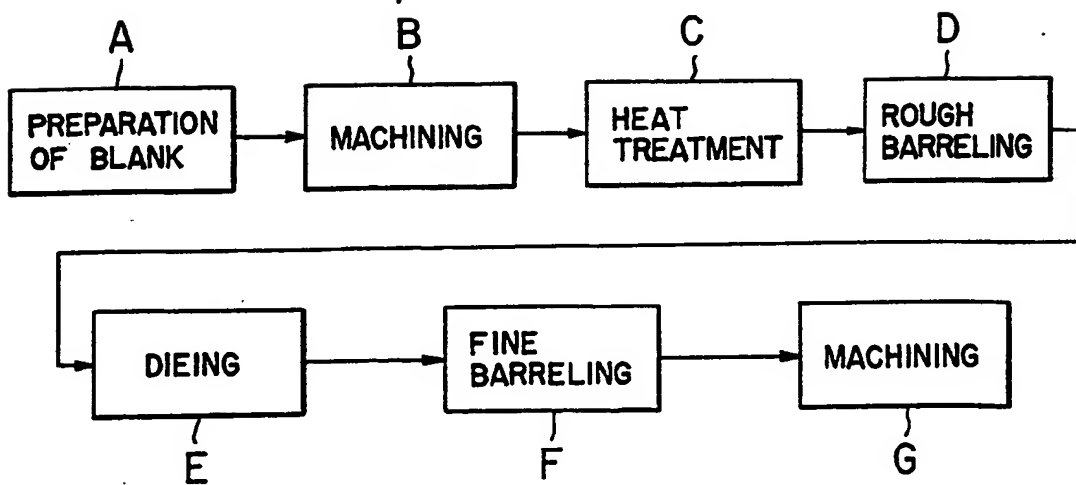


FIG. 5

BALL CONSTRUCTION OF A BALL-AND-SOCKET JOINT  
AND METHOD OF MANUFACTURE

5        This invention relates generally to joints and in particular to a ball-and-socket joint suitable for use in suspension systems and steering linkages of motor vehicles, among other applications. More particularly, the invention deals with the improved construction of a ball member in such a ball-and-socket joint, for which construction is designed for lubrication of the device. The invention also pertains to a method of fabricating the ball member.

15        The ball-and-socket joint of the class under consideration consists largely of a ball member having a stud or shank ending in a ball, and a socket member defining a socket for slidably receiving the ball. The ball is shaped like a sphere or like a segment of a sphere for free angular displacement with respect to the socket member. U.S. Patent No. 4,629,352 to Nemoto represents an example of such a joint.

25        One of the essential requirements for this type of joint is the reduction of the sliding resistance between the ball and socket surfaces. The reduced sliding resistance must, moreover, be enduring in order to assure minimal starting torque and steady-state torque throughout the expected lifetime of the joint. Japanese Examined Utility Model Publication No. 53-24626 and Japanese Unexamined Utility Model Publication No. 30 56-115030 suggest solutions to this problem. These conventional solutions are more or less alike in teaching the creation of lubricant grooves in the ball. Such grooves have been formed by either forging or cutting.

35        The known solutions have proved to have some drawbacks. First, the creation of lubricant grooves by forging have demanded the use of forging dies of very complex shapes, having as many ridges on the die surfaces

as the required number of lubricant grooves in the ball. The cutting of lubricant grooves is also objectionable by reasons of the waste arising from the partial removal of the metal stock, and the time-consuming operation  
5 involved.

The elongate lubricant grooves are themselves objectionable because they have had to be formed all over the ball surface for sufficient lubrication. Consequently, the greater the reduction in the sliding  
10 resistance between the ball and socket members, the lesser the mechanical strength of the ball. The provision of such many lubricant grooves has also made the joint very costly because of the complex manufacturing process.

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The present invention solves the problem of how to minimize the sliding resistance between the ball and socket members without the above discussed difficulties encountered with the prior art.

20 Briefly, the invention may be summarized as a ball-and-socket joint having a ball member and a socket member, with the ball member including a ball slidably engaged in a socket defined by the socket member for permitting the relative angular displacement of the ball  
25 member and the socket member. The invention is particularly characterized by the fact that the ball has a multiplicity of minute depressions or concavities formed in its surface for receiving a lubricant during the use of the ball-and-socket joint. The boundary  
30 between the surface of the ball and each depression therein is rounded, instead of being sharp-edged, so that the lubricant readily flows into and out of the depressions for lubricating the mating surfaces of the ball and the socket with the relative angular  
35 displacement of the ball member and the socket member.

The depressions are each in the shape of a shallow bowl and are formed all over the ball surface. They

serve not only the purpose of receiving a lubricant but also that of materially reducing the surface area of the ball that makes contact with the socket member. Also, as the ball angularly slides within the socket member during  
5 the use of the ball-and-socket joint, the lubricant will readily flow into and out of the depressions by virtue of their rounded boundaries and so will constantly lubricate the contacting surfaces of the ball and the socket. These reasons combine to minimize the sliding resistance  
10 between the two members and to minimize it during extended periods of use of the joint.

An additional advantage of the invention is that the depressions in the ball surface are easy to form as by barreling or tumbling. This method of creating the  
15 depressions is preferred to the conventional forging or cutting method because of its freedom from the inconveniences that have been previously pointed out in connection with the prior art.

The above and other objects and features of this  
20 invention and the manner of realizing them will become more apparent, and the invention itself will best be understood, from a study of the following description and appended claims, with reference had to the attached drawings showing a preferable embodiment of the  
25 invention.

FIG. 1 is an axial section through the ball-and-socket joint embodying the principles of the invention;

FIG. 2 is a greatly enlarged, fragmentary section  
30 through the ball of the device of FIG. 1, the view showing some of the numerous depressions formed in the ball surface;

FIG. 3 is a perspective view of an example of a chip that may be employed in barreling the ball for the  
35 creation of the depressions in its surface;

FIG. 4 is a perspective view of another example of chip that may be employed in barreling the ball for the creation of the depressions in its surface; and

FIG. 5 is a flow chart explanatory of the sequential 5 steps of fabricating the ball member of the device of FIG. 1.

The general construction of the ball-and-socket joint according to the invention will now be described in 10 terms of its preferred form illustrated in FIG. 1. Generally designated 10, the exemplified ball-and-socket joint broadly comprises a ball member 12 and a socket member 14. The ball member 12 has a shank or stud 16 terminating in a ball 18 at one end and a threaded 15 extension 20 at the other. The ball 18 is shown to be truncated at 22. The socket member 14, which is shown as a simple molding of more or less resilient and wear-resisting material, defines a spherical socket 24. The ball 18 is slidably lodged in this socket 24.

20 The ball-and-socket joint 10 additionally comprises a joint housing 26 of rigid material and of substantially tubular shape in which the socket member 14 is snugly received. The joint housing 26 has two openings 28 and 30 at its opposite ends. The first opening 28 is left 25 open to permit the shank 16 of the ball member 12 to extend therethrough with clearance. The second opening 30, larger than the first opening 28, is permanently closed by an end plate 32. Engaged in an annular groove 34 in the inside surface of the joint housing 26, the end 30 plate 32 is retained in position by clinching the end of the housing at 36.

Also included is a dust cover 38 of elastomeric material for dustproofing the mating surfaces of the ball member 12 and the socket member 14. The dust cover 38 is 35 shown to be substantially tubular in shape, with one end, defining a larger diameter opening 40, engaged in an annular groove 41 in the joint housing 26 and clamped at

42 thereto. The other end of the dust cover 38 has a smaller diameter opening 44 to permit the shank 16 of the ball member 12 to closely extend therethrough. The dust cover 38 is so elastic that the ball member 12 is capable  
5 of free angular displacement with respect to the socket member 14.

FIG. 2 is a greatly enlarged, sectional illustration of the surface 46 of the ball 18 of the ball-and-socket joint 10. It will be seen from this figure that,  
10 although shown fragmentarily, the ball surface 46 has a multiplicity of minute concavities or depressions 48 of more or less bowl shape formed all over. Produced by the method of the invention, which is to be set forth subsequently, the minute depressions 48 are of necessity  
15 somewhat indefinite in shape and size, as pictorially represented in FIG. 2. Mostly, however, the depressions 48 can be described as being in the shape of a comparatively shallow bowl, each having a depth  $D_e$  less than a diameter  $D_i$  as measured at the outer end. It is  
20 also important to note that the annular boundary 50 between the ball surface 46 and each depression 48 is not sharply delineated but rather gently curved.

Typically, as produced by the method of the invention, the minute depressions 48 were mostly less  
25 than 3.5 micrometers in depth. The maximum depth was 6.0 micrometers.

In the use of the ball-and-socket joint 10, the depressions 48 in the ball surface 46 are to be filled with any suitable lubricant that may be employed with  
30 this kind of joint. The lubricant will easily flow out of and back into the depressions 48 by virtue of their gently curved boundaries 50 with the relative angular sliding motion of the ball 18 and the socket 14. The complete mating surfaces of the ball and socket can thus  
35 be constantly and uniformly lubricated to reduce sliding resistance to a minimum.



The invention further proposes the creation of the depressions 48 in the ball surface 46 by barreling or tumbling the ball member with the use of chips of hard or abrasive material. FIGS. 3 and 4 show examples of chips  
5 that may be employed. The chip 52 of FIG. 3 is in the shape of a column of triangular cross section. The chip 54 of FIG. 4 is spherical in shape. Either or both of the two kinds of chips 52 and 54 may be adopted for the barreling of the ball 18.

10       Reference may be had to FIG. 5 for a study of the method of fabricating the ball member 12 of the ball-and-socket joint 10 according to the invention. There is first prepared a blank for the ball member 12 as at A in FIG. 5. The blank is machined or cut to shape as at B.  
15 The next step is heat treatment C which is followed by rough barreling D of the ball portion of the blank. The rough barreling is carried out to remove surface scale produced by the heat treatment. The rough barreling makes the ball surface so coarse that it must be smoothed  
20 as by dieing E.

Next comes the step of the fine barreling F of the blank for the creation of numerous minute shallow depressions 48 in the ball surface. The blank may be barreled using the chips 52 of FIG. 3, the chips 54 of  
25 FIG. 4, or both. It is an advantage of this barreling method that a number of ball member blanks can be speedily processed at the same time. For example, about 100 to 150 blanks may be charged into a barrel together with a mixture of the two kinds of chips 52 and 54 and  
30 may be ~~tumbled~~ about 10 to 15 minutes. The required depressions 48 will be formed over the entire surfaces of the ball portions. Another advantage of the barreling method is that minute depressions of desired size and shape can be created with certainty only if a required  
35 set of barreling conditions such as the amount and kind of chips for use and the time of processing are ascertained. The size and shape of the chips and other

conditions depend in part on the desired performance characteristics of the ball-and-socket joints to be produced.

Following the creation of the minute depressions in  
5 the ball surface by barreling, the screw thread 20 is conventionally machined on the extension of the shank 16, as at G in FIG. 5. The production of the ball member 12 has now been completed.

It is not desired that the invention be limited by  
10 the exact details of this disclosure. For example, the depressions in the ball surface may be formed by shot blasting or shot peening with use of steel balls or equivalent hard chips, instead of by barreling as in the foregoing disclosure. A variety of additional  
15 modifications or alterations of the invention may be resorted to without departing from the scope of the invention.

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CLAIMS:-

1. A ball-and-socket joint having a ball member and a socket member, with the ball member including a ball slidably engaged in a socket defined by the socket member for permitting the relative angular displacement of the ball member and the socket member, wherein the ball has a multiplicity of minute depressions formed in its surface for receiving a lubricant during use of the ball-and-socket joint, and that the boundary between the surface of the ball and each depression therein is rounded so that the lubricant readily flows into and out of the depressions for lubricating the mating surfaces of the ball and the socket with the relative angular displacement of the ball member and the socket member.

2. A ball-and-socket joint as claimed in Claim 1, wherein each depression in the surface of the ball is substantially in the shape of a bowl, and that each depression has a depth less than its diameter.

3. A method of fabricating a ball of a ball-and-socket joint having a ball member and a socket member, with the ball member including the ball slidably engaged in a socket defined by the socket member for permitting the relative angular displacement of the ball member and the socket member, said method including the step of striking the surface of the ball with chips of hard material for forming therein a multiplicity of minute depressions for receiving a lubricant during use of the

ball-and-socket joint.

4. A method as claimed in Claim 3, wherein the depressions in the ball surface are created by barreling.

5. A method as claimed in Claim 4, wherein the barreling includes a fine barreling which follows a dieing.

6. A method as claimed in Claim 3, wherein the depressions in the ball surface are created by shot blasting.